Introduction

This monograph seeks a unified theory of embodied cognition by gathering together work in cognitive science, experimental psychology, neuroscience, anthropology and philosophy of mind. It will attempt to persuade the reader that human cognition is not a biological given, but in large part a cultural artefact, invented by successive generations of especially dexterous primates.

The bulk of the text will be concerned with the mundane. Buried within the everyday bodily actions of humans is the key to understanding their more celebrated achievements. We tend to take much of what we do in the world for granted. This is not surprising because we just do most of it, seemingly without any great effort. Consider this typical scene from a – typical day in a typical metropolitan culture. A mother, father and three children are gathered together for breakfast. All have a busy day ahead of them. The parents both work and the children attend school. Breakfast is a rushed affair, and everyone is helping with its preparation, except the eldest child, a teenage boy who is seated at a table sending a text message with a flurry of thumbs on his smartphone screen. The father is standing behind the boy and passes a jug of milk over the boy's head to his daughter standing on the opposite side of the table. He holds the jug around its base so that his daughter can securely grasp it by the handle. She places the jug at the centre of the table. Her sister, who has been preparing a pot of coffee, arrives at the table and places it alongside the milk jug. The mother adds a basket of bread and pastries. They all now sit and begin a seemingly orchestrated exchange of bowls, cups and food stuffs. Liquids are poured, and bread is cut. Conversations begin. The father asks the boy if he finished his homework the previous evening. The boy simply smiles in response. The mother, witnessing this exchange, raises her eyebrows, but changes the theme of the conversation. She asks her husband to call into the shops on his way home that evening to buy the ingredients for the evening meal, telling him she has left a list on the table by the front door.

The music that has been playing in the background now switches to a weather forecast. It will rain heavily in the afternoon. There are hurried conversations about changing their plans as a consequence. The mother decides to collect her daughters from school by car, rather than their usual routine of walking home. And so, it goes on; this routine and familiar coping in the world. We tend to think that there are no great accomplishments here; no acts of creative genius. But if we delve just a little into these routine exchanges between humans and the objects in their world it becomes clear that they depend on quite remarkable abilities, many unique to our species.

Probably the most immediately striking in this regard is the extensive use of symbolic exchanges. Much of the activity is immersed within, and depends, on spoken language: requests for objects to be passed, enquiries about past events and dialogues about plans for future events. But there also other symbolic 'props'. The written shopping list placed by the front door is an augmentation of unreliable human memory. The radio provides information about events distant in time and space, as does the smartphone, which in addition allows communication, using written or spoken language, with people not currently present. There are other types of communication too. The meaning of the son's wry smile and the mother's raised eyebrow in response is transparent. The two humans appear to have an almost direct access to the other's state of mind as a consequence of the merest facial expression. Look a little closer and there appear to be many other cases of 'mind reading'.

The simple act of passing an object, such as the milk jug, from one person to another involves precise coordination between the two agents, which depends on an element of prediction. The grasping hand of each person must arrive at a position in space and be oriented so as allow the one to maintain an effective grip until the moment of exchange, and the other to find a place to grasp at the same moment. The degree of dexterity and coordination of such actions is almost certainly unique to humans. As is, of course, the making of artefacts that facilitate this joint activity, such as the handled milk jug which allows a precision grip to secure the object and use it effectively or to take it from another person who offers it by grasping it with a power grip around its body with the handle orientated towards the recipient. Or the smartphone which allows the very mobile human thumb to dance across its screen.

Other important aspects of the scenario are entirely hidden from view. Our observations and description of an unfolding scenario such as this is likely to be highly anthropocentric: we tend to notice what the humans are doing or saying, and mostly ignore the other entities. The people are the actors and prime movers of events. In fact, as will be made clear as we

proceed, the objects on which the humans act are not passive. They summon behavioural responses from the actors and are active participants in the acts of object exchange for example. The precise posture of a hand as it closes on a three-dimensional object is potentiated by the visual properties of the to-be-grasped object, its shape and orientation. The objects in the scene assist human activities in other ways. Objects in the world are arranged so as to facilitate actions, for example jugs and pots and cups are placed on the table within the reaching space of those sitting around it. The placing of the shopping list by the front door, so as to draw attention to it as the father leaves the house, is another example, but now its placement is an external support for an act of remembering, rather than reaching. Both are illustrations of external scaffolding, a term widely used in embodied accounts of cognition. That is, they serve to augment the mental and physical activities of an individual. Moreover, much of what we do depends on external scaffolding of some sort, so, and this is very important for what follows in the main text, the essential processes and mechanisms of cognition are not confined to those internal to the person. They extend beyond the body.

The text that follows has the aim of illuminating the connections between these various and, seemingly, very different human behaviours. The central argument is that they are intrinsically interwoven. Human dexterity and sociality are the foundations on which human cognition has been built. At some point in the evolution of the ancestors of *Homo sapiens* it became possible for them to fabricate and use stone tools. With these technical skills, it was possible to constantly reconstruct and enrich their environmental niche which forced adaptations in subsequent generations, allowing an expansion in group size and thereby placing increasing demands on coordination among the members of the group. The need to predict the actions of others when engaged in joint actions, to read their minds, became important. Simultaneously or subsequently explicit communication augmented this implicit dialogue, with, again, their dexterity making it possible for them to use gesture in a prototype language, which with subsequent elaborations became a spoken language. Such refinements in, now, our social and *material* cultural provided novel forms of scaffolding and formed the basis of the paradoxical explosion in human capacities that *came after* the fixing of the human genome. In particular symbol systems, including written language, took us from the late Palaeolithic to the space age.

In abstracting from mundane joint activity in a world of objects, cognitive science has tended to neglect the essential mutual dependencies of the sort just sketched. It is perhaps guilty of an excessively individualistic

approach, in that its centre of attention has been the capacities of the lone agent responding to, rather than acting on, very impoverished fragments of their world. It might be argued, in its defence, that such abstractions are essential to the process of scientific analysis. To understand the psychophysical properties of the human visual system, say, it is necessary to methodically investigate its capacities and properties, in isolated, empty handed and largely immobile individuals. Yet this way of understanding vision misses much that is important. For example, we humans are fairly good at judging middle-range distances, say, seeing whether the coffee pot is reachable from where you sit at the breakfast table. This 'seeing' of a distance is not the outcome of purely visual processes. Rather it also depends on the potential for acting on the object: whether you can actually reach the pot and whether you intend to. This was demonstrated by Witt, Proffitt and Epstein (2005) who had participants judge the distance of targets while either holding a tool or not. Their estimates of distance were reduced while holding the tool, but only if they intended to reach towards the target. This dependence of a perceptual judgement on a bodily capacity and an intention to act on the world illustrates the way our understanding of cognition is incomplete if it is considered independent of bodily activity in the world.

There are many, many similar demonstrations of a close link between action and perception. Also, between action and higher-level cognition. These observations have tended to form the core of what might be termed a school of embodied cognition, within which various ideas on how to account for the data contend. This, rather loose, coalition tends to draw on particular modern philosophical traditions. Chapter 1 attempts to make sense of these diverse ideas and their, as it turns out, rather awkward philosophical bedfellows. Chapter 2 discusses the human visual system so as to illustrate an embodied understanding of perception in which the detection of behavioural possibilities is central, and thus contrast this with an orthodoxy that treats the perceiver as a passive recipient of sense data from which descriptions of the external world are derived. Chapter 3 focuses on tool use and its role in sculpting the human perceptual-motor system during evolution and individual lifespans, noting that skilled tool use results in an extension of the agent's effective body. Chapter 4 places the agent in their social context and discusses the implications of recent work investigating the human mirror neurone system. It will be claimed that joint action on objects is the key to understanding its function. Chapter 5 attends to the role of physical objects in shaping human societies and human brains. It will argue that the neglect of human material culture within

cognitive science has led it to underestimate the degree to which human cognition is a cultural artefact. Chapter 6 treats language as a special case of a cultural artefact and speculates that it arose as an elaboration of the skills needed to cooperate with others in joint actions. The seventh, and final chapter attempts to synthesise the arguments to form a unified framework for cognition and an associated research programme.